INL Demonstration Reactor Infrastructure

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National Reactor Innovation Center (NRIC)

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www.inl.gov

Idaho National Laboratory

National Reactor Innovation Center (NRIC) authorized by Nuclear Energy Innovation Capabilities Act (NEICA)

- DOE Launched NRIC on August 15, 2019
- The National Reactor Innovation Center is intended to:
  - Enable testing and *demonstration of reactor* concepts
  - Access to *infrastructure*
  - Led by INL, coordinating with other national labs

Sen. James Risch, R-Idaho, left, and Sen. Mike Crapo, R-Idaho, speak to audience members during the announcement of the launch of the National Reactor Innovation Center (NRIC) at Idaho National Laboratory on Wednesday, Aug. 14, 2019. NRIC will support private sector nuclear developers in their work to develop concepts and assess their performance according to a INL news release.
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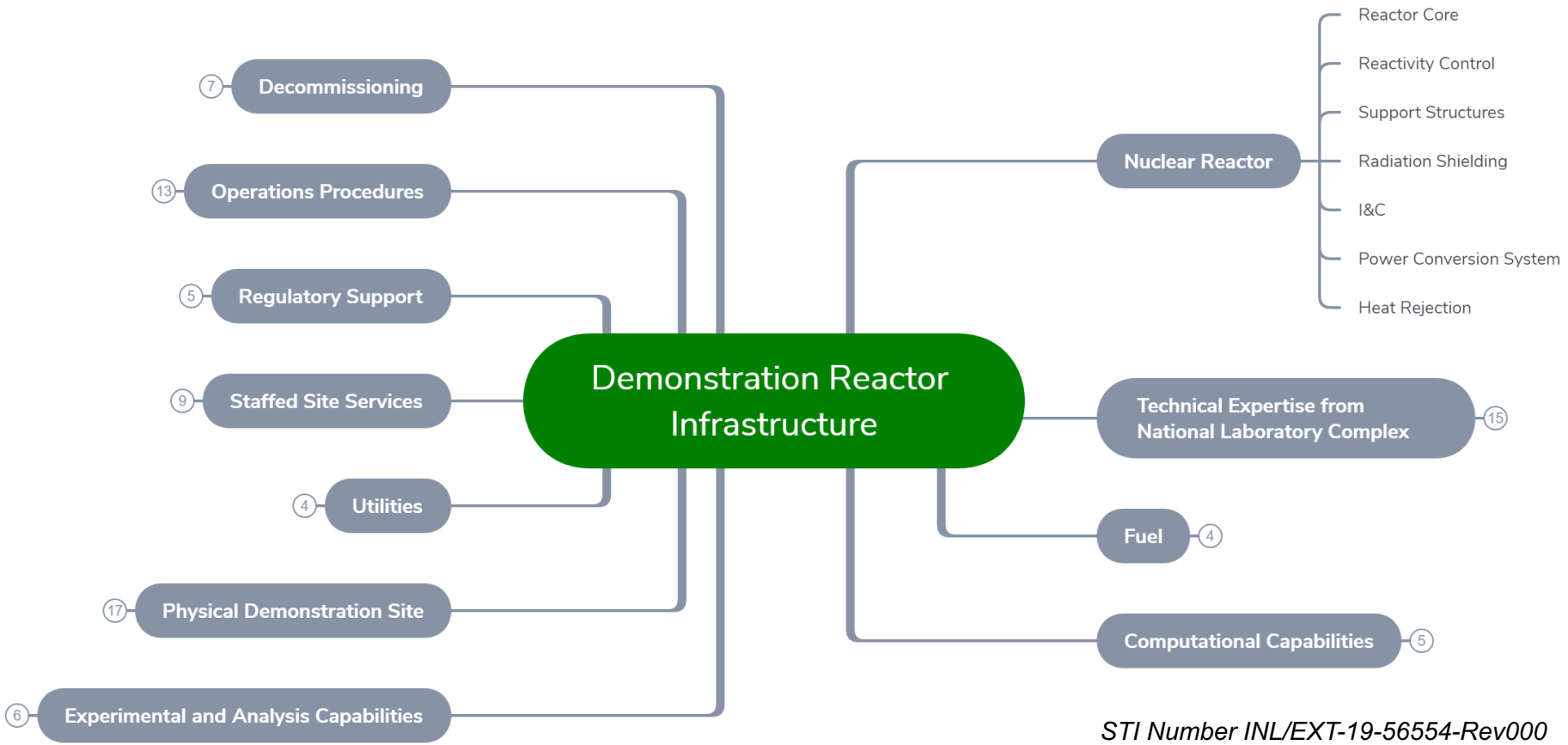
Nuclear Reactor



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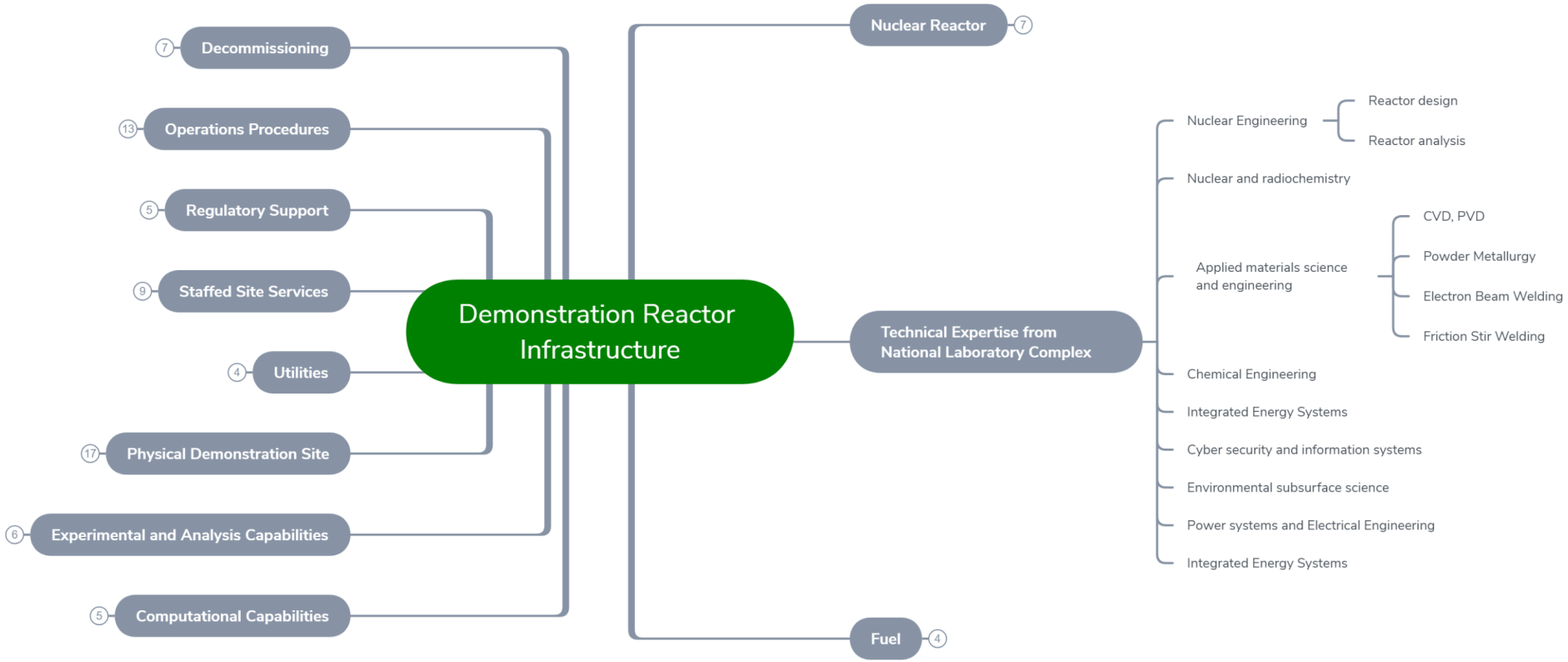
Technical Expertise from National Laboratory Complex



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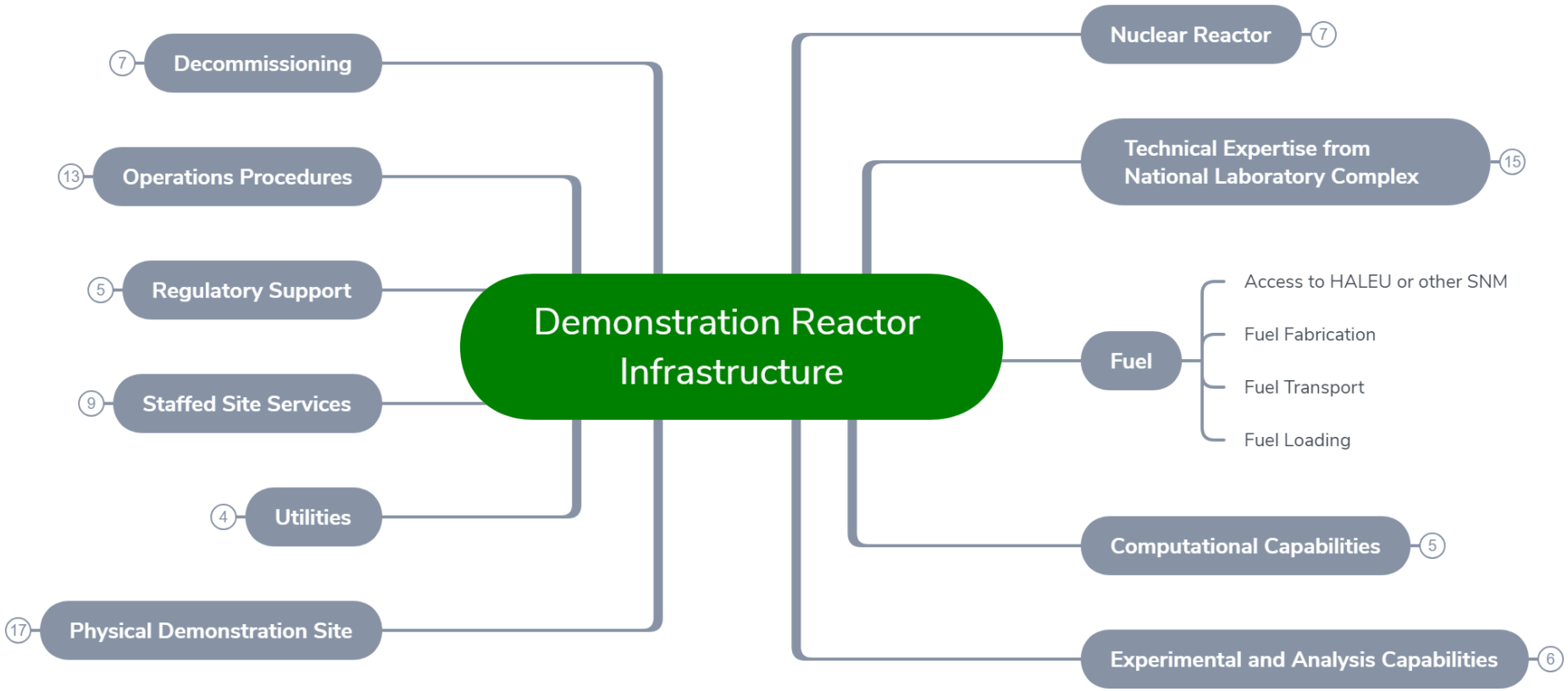
Fuel



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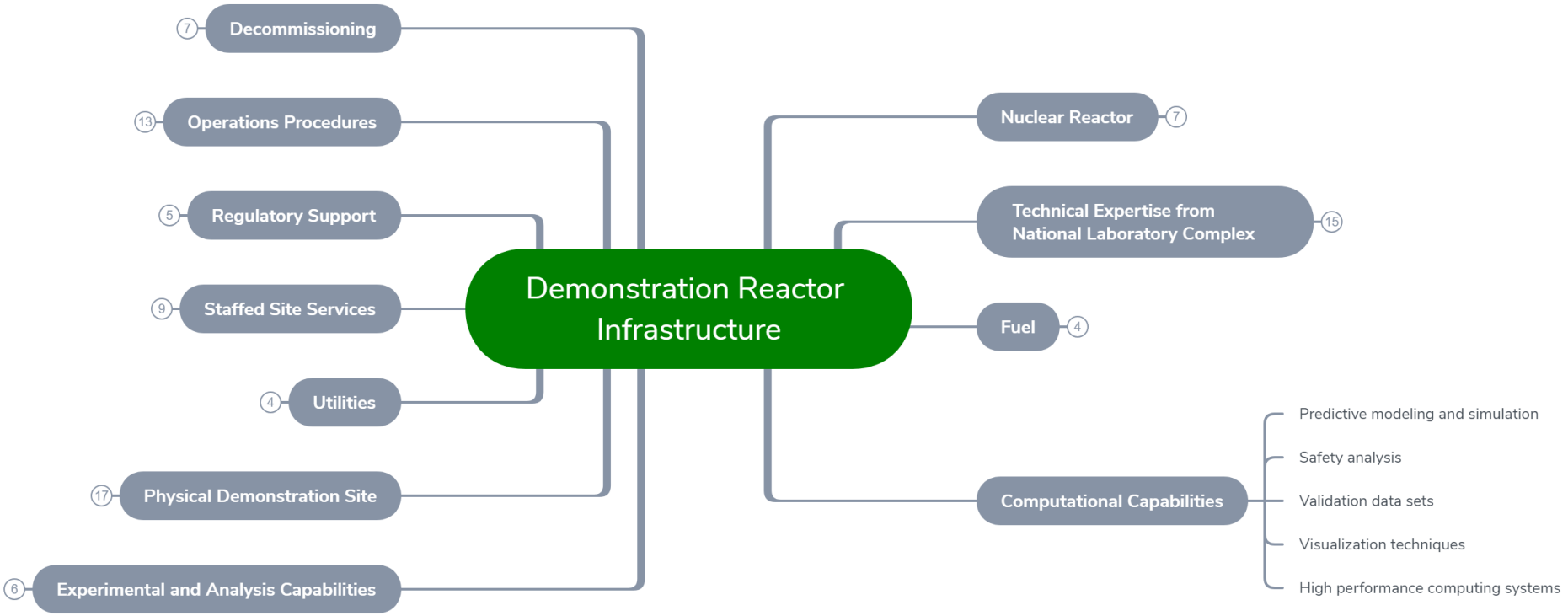
Computational Capabilities



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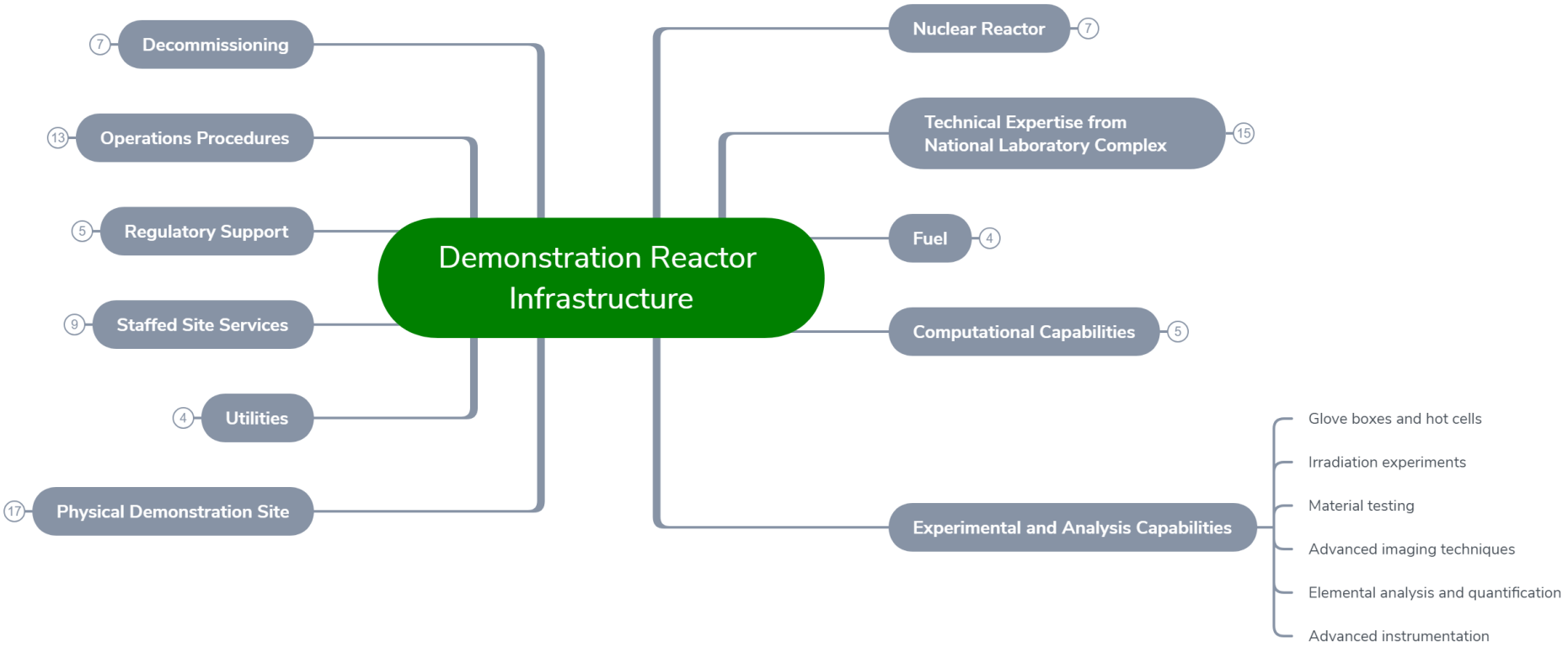
Experimental and Analysis Capabilities



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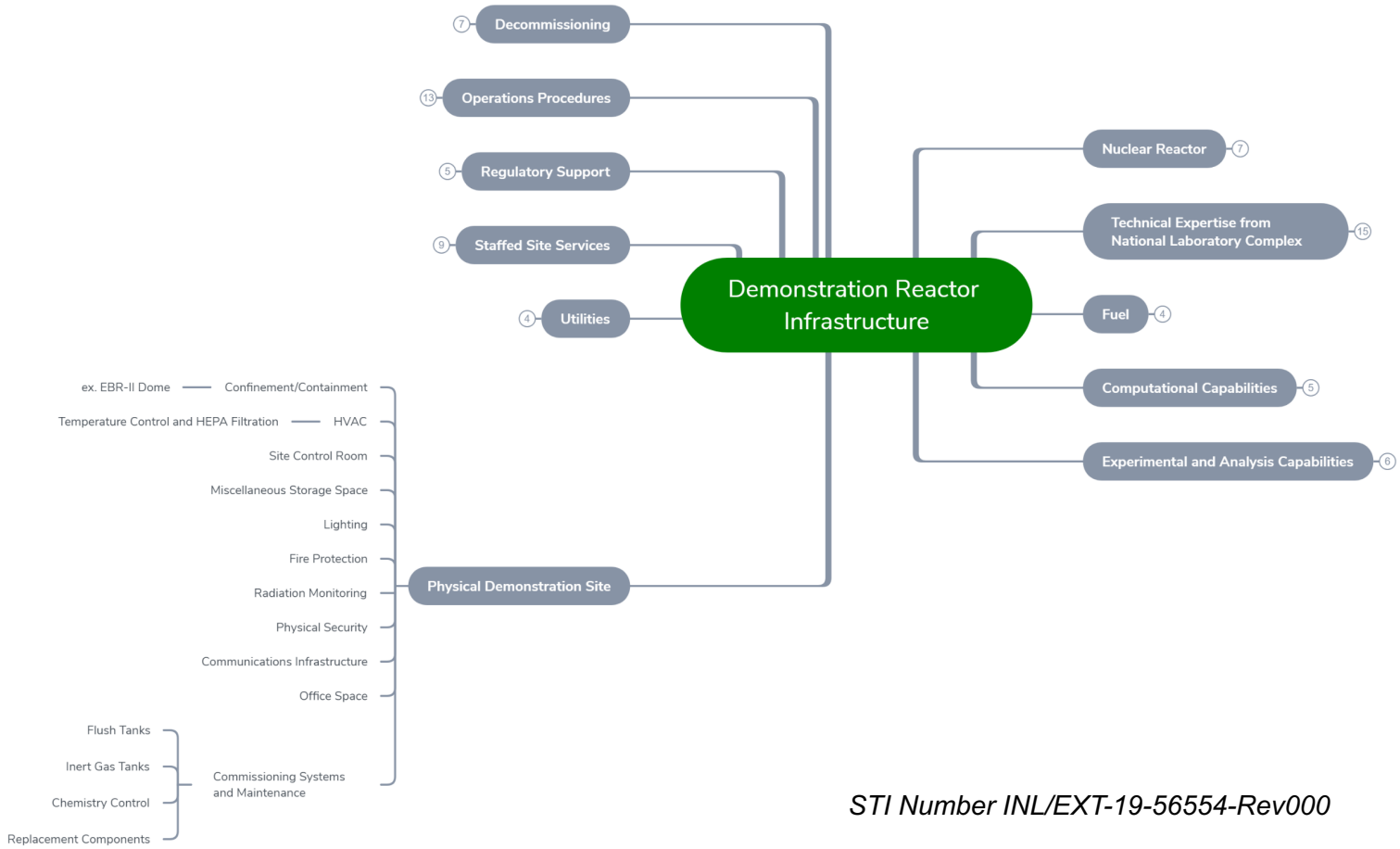
Physical Demonstration Site



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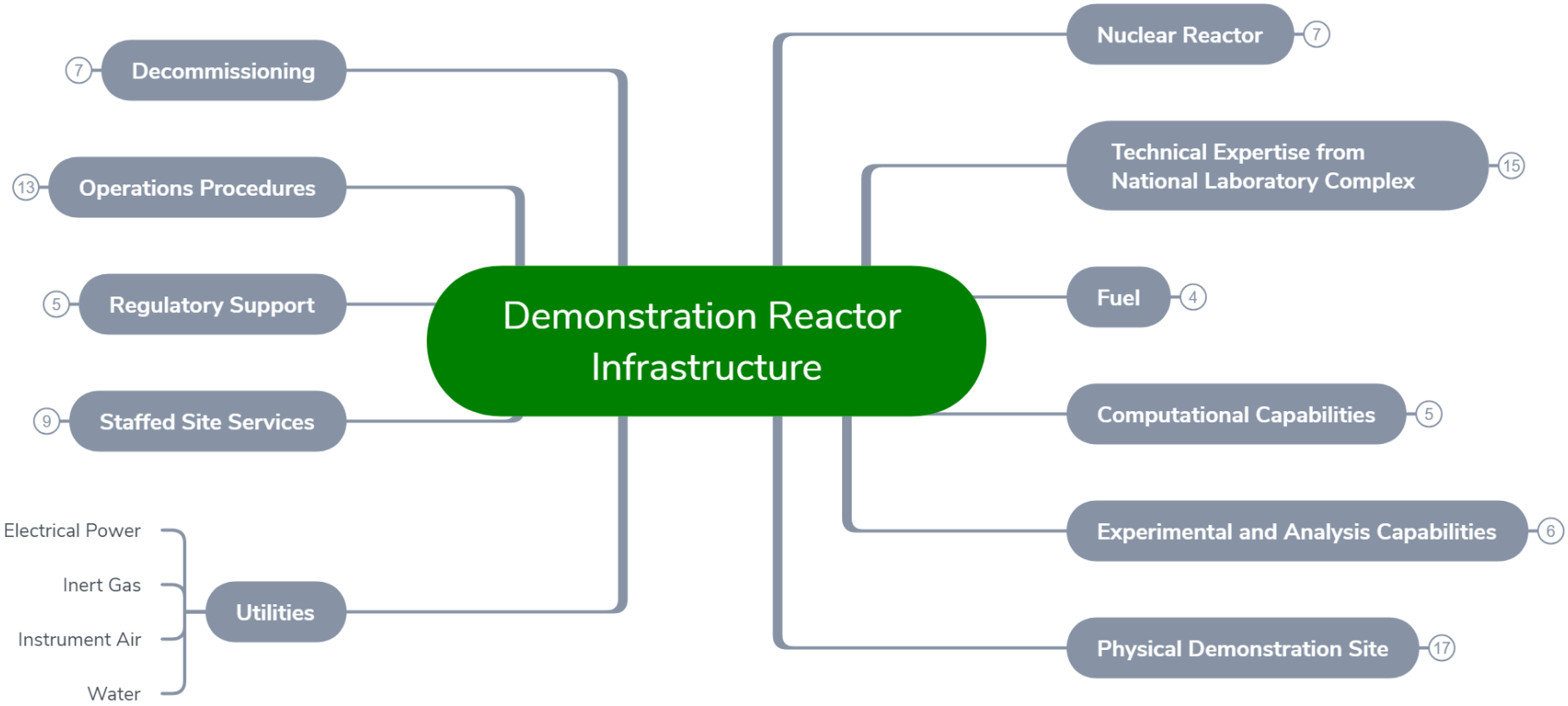
Utilities



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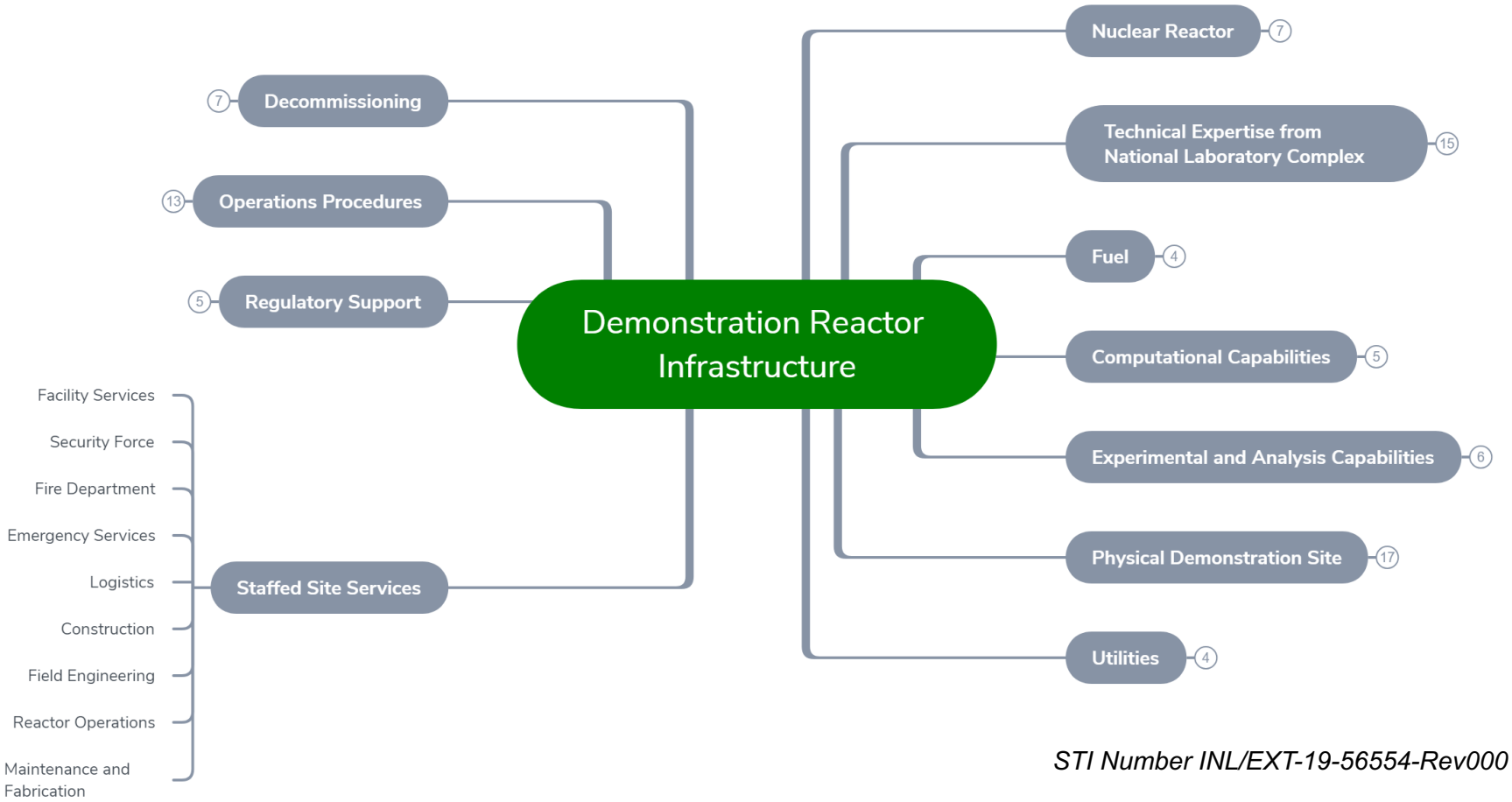
Staffed Site Services



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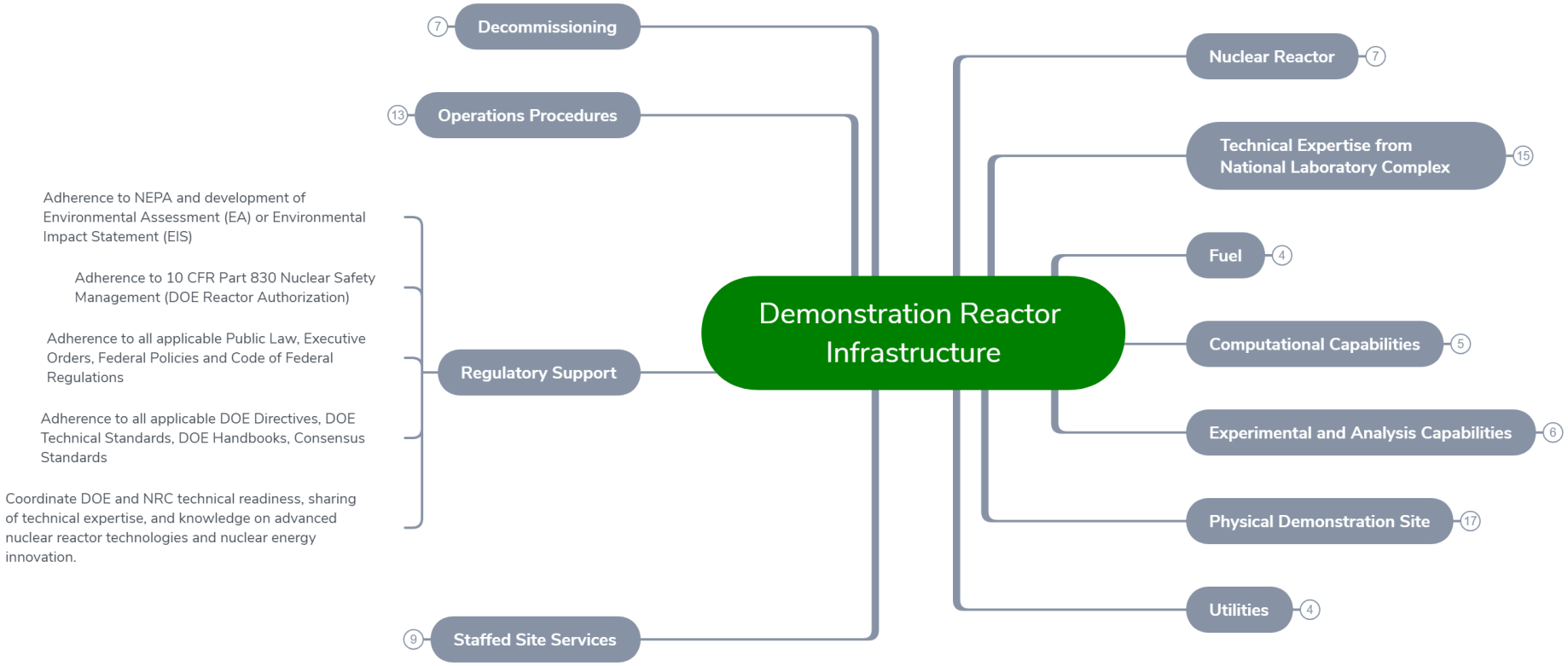
Regulatory Support



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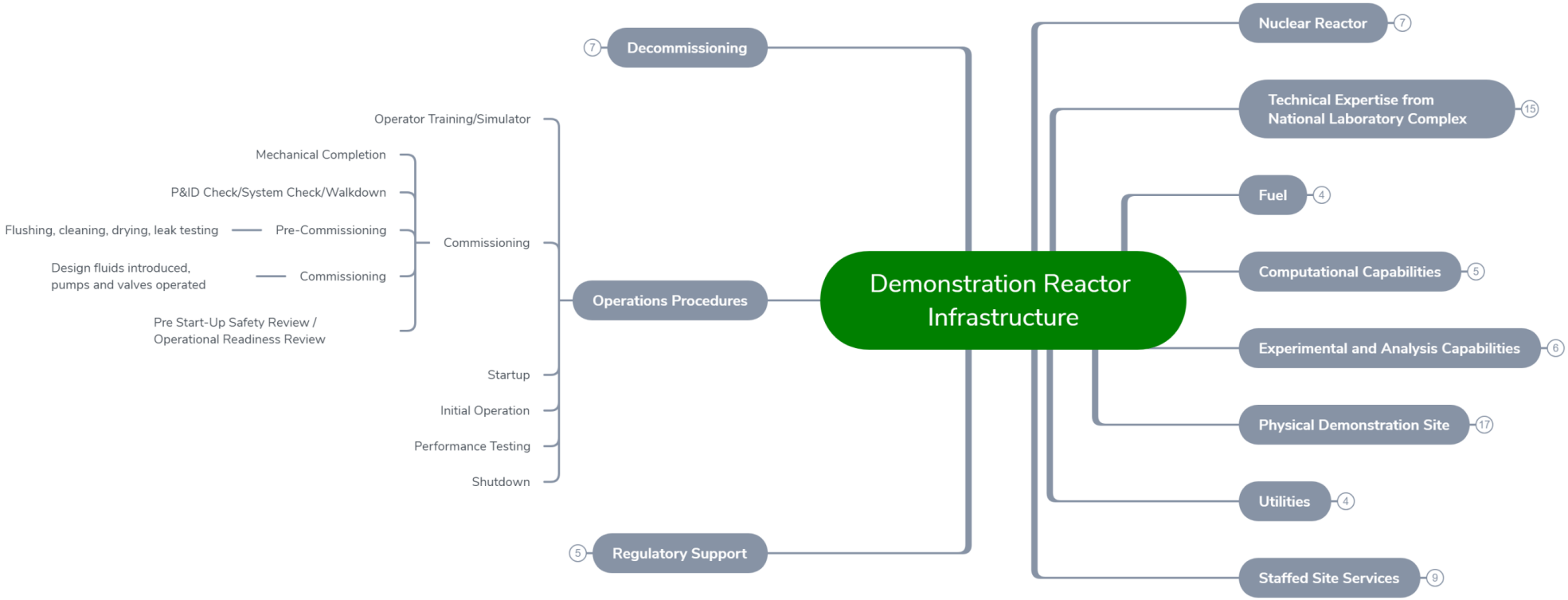
Operations Procedures



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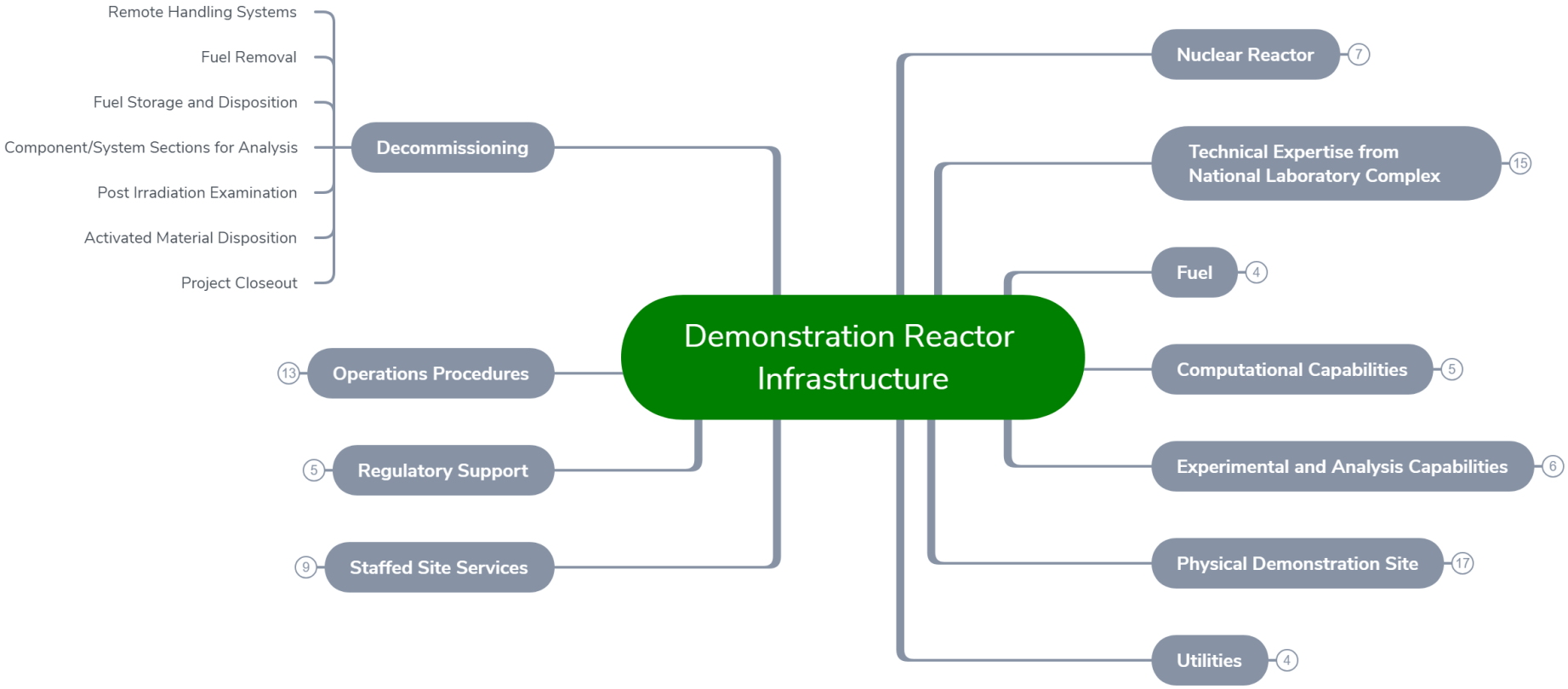
Decommissioning



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The EBR-II Dome has great potential as a demonstration reactor site

- Experimental Breeder Reactor-II Dome (EBR-II) MFC-767
- 78ft internal diameter, 87ft tall from ground level at highest point, walls are 1ft thick rebar reinforced concrete with 1inch of steel plating on outer side. Leak tight to 24psi.
- Safeguards category 2, hazard category 2
- Floor loading capacity of 3,750 pounds per square foot
- Two lightly loaded 2MVA transformers. 13.8kV or 480V service could be supplied
- 75ton overhead crane was damaged during decommissioning, could be repaired (est. cost ~$3M)
- Has been seismically qualified in the past, (est. cost ~$300k to recertify)
- Upgrades needed:
  - Larger containment penetration needed for equipment (currently only 6ft x 6ft door)
  - Installation of cooling capacity needed
  - Electrical power, instrument air, argon, and nitrogen not currently installed
  - Repairs to overhead crane
- Excellent radiation protection, very large space, co-located with MFC for access to infrastructure

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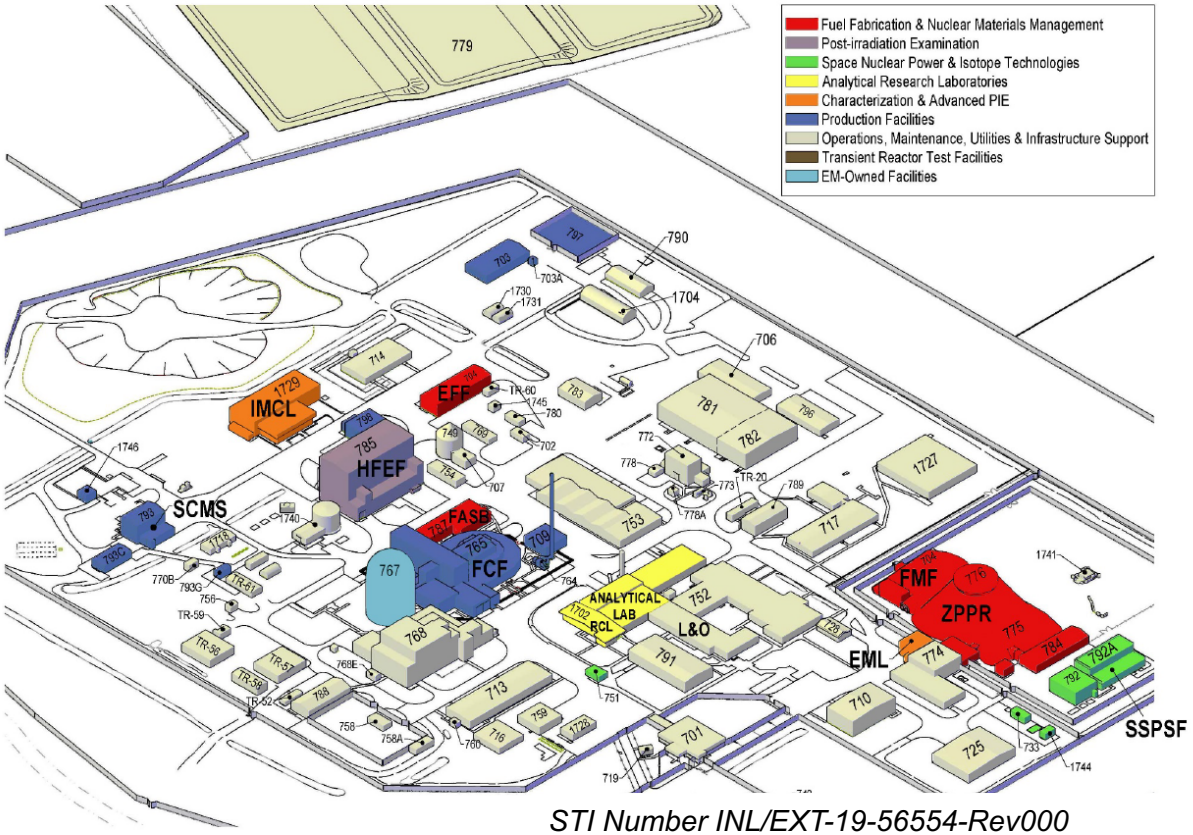
INL's Materials and Fuels Complex (MFC) offers world class infrastructure to support demonstration reactors

- IMCL- Irradiated Materials Characterization Laboratory
- HFEF- Hot Fuels Examination Facility
- EML- Electron Microscopy Laboratory
- FASB- Fuel and Applied Science Building
- AL- Analytical Laboratory
- EFF- Experimental Fuels Facility
- FCF- Fuel Conditioning Facility
- RCL- Radiochemistry Laboratory
- MFC-767 (EBR-II) Experimental Breeder Reactor-II Dome



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Irradiated Materials Characterization Laboratory (IMCL) MFC-1729

- Irradiated Materials Characterization Laboratory (IMCL) MFC-1729
  - Recently installed thermophysical glovebox/hot cell
    - Thermophysical characterization of metallic and oxide nuclear fuels.
    - Allows for remote manipulation of highly radioactive samples via master/slave manipulators on the hot cell side of box
    - Part of National Science User Facility (NSUF)
  - Abundant microscopy resources
  - Differential Scanning Calorimetry (DSC) — Specific Heat
  - Thermogravimetric Analyzer (TGA) — *When combined with DSC*
    - melting temperature, crystallization temperature, phase changes, enthalpy, volatility
  - Laser Flash Analysis (LFA) — Thermal Conductivity, Thermal Diffusivity
  - Gas Chromatograph
  - Surface Morphology, Elemental Analysis, Grain Structure, Corrosion Rates, Lattice Defects
    - Focused Ion Beam (FIB)
    - Energy Dispersive X-Ray Spectroscopy (EDS)
    - Electron Backscatter Diffraction (EBSD)
    - Transmission Electron Microscopy (TEM)
  - Electron Probe Microanalyzer (EPMA) — Elemental Mapping
  - Optical Microscopy — Surface and Cross Section Imaging
  - Microindentation, Microhardness Testing System — Material Hardness and Ductility
  - X-ray Diffraction (XRD) — Crystal Structure, Phase Analysis, Interplanar Spacing
  - Sample Prep Equipment — Polishing, Cross Sectioning
  - Metrology Equipment — Analytical Balances, Micrometers, etc.

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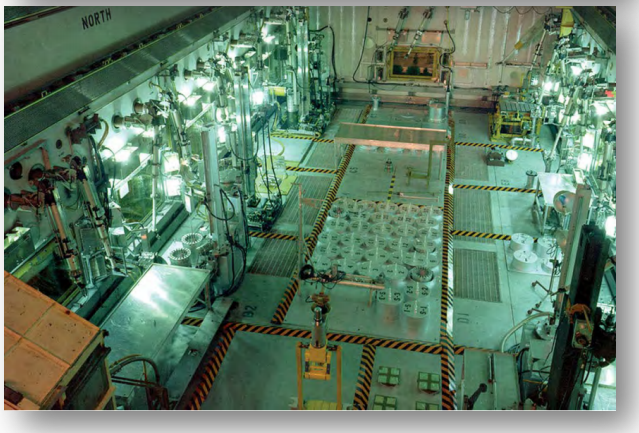
Hot Fuels Examination Facility (HFEF) MFC-785
Fuel and Applied Science Building (FASB) MFC-787



Hot Fuels Examination Facility (HFEF) MFC-785

- Large number of experiments ongoing, variable atmosphere quality
- Electrochemistry — Energies of formation, redox potentials, chemical activity,
- Bubbler — Surface Tension, Contact Angle, Interfacial Behavior (Foaming, Wetting of Surfaces)
- Tensile Strength
- Creep Strength
- Fatigue
- Fracture Toughness
- Bending Strength
- Microindentation, Microhardness Testing System — Material Hardness and Ductility
- Sample Prep Equipment — Polishing, Cross Sectioning
- Metrology Equipment — Analytical Balances, Micrometers, etc.
- Neutron Radiography — NRAD (TRIGA)

Fuel and Applied Science Building (FASB) MFC-787

- Differential Scanning Calorimetry (DSC) — Specific Heat
- Thermogravimetric Analyzer (TGA) — *When combined with DSC* — melting temperature, crystallization temperature, phase changes, enthalpy, volatility
- Electrochemistry — Energies of formation, redox potentials, chemical activity,
- X-ray Diffraction (XRD) — Crystal Structure, Phase Analysis, Interplanar Spacing
- X-ray Fluorescence (XRF) — Elemental, Chemical Analysis
- Sample Prep Equipment — Polishing, Cross Sectioning
- Metrology Equipment — Analytical Balances, Micrometers, etc.

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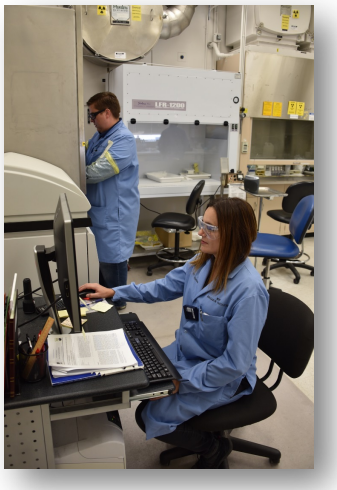
Electron Microscopy Laboratory (EML) MFC-774
Analytical Laboratory (AL) MFC-752

- Electron Microscopy Laboratory (EML) MFC-774
  - Abundant microscopy resources
  - Scanning Electron Microscopy (SEM)
  - Surface Morphology, Elemental Analysis, Grain Structure, Corrosion Rates, Lattice Defects
    - Focused Ion Beam (FIB)
    - Energy Dispersive X-Ray Spectroscopy (EDS)
    - Electron Backscatter Diffraction (EBSD)
    - Transmission Electron Microscopy (TEM)
  - Sample Prep Equipment — Polishing, Cross Sectioning
  - Metrology Equipment — Analytical Balances, Micrometers, etc.



- Analytical Laboratory (AL) MFC-752
  - Differential Scanning Calorimetry (DSC) — Specific Heat
  - Thermogravimetric Analyzer (TGA) — *When combined with DSC* — melting temperature, crystallization temperature, phase changes, enthalpy, volatility
  - Laser Flash Analysis (LFA) — Thermal Conductivity, Thermal Diffusivity
  - X-ray Fluorescence (XRF) — Elemental, Chemical Analysis
  - Alpha Spectroscopy — Identification and quantification of alpha emitting isotopes
  - Gamma Spectrometry with high purity germanium detectors — Identification and quantification of gamma emitting isotopes
  - Gas Pressurized Extraction Chromatography — Uses pressurized nitrogen to push solutions through media instead of liquid or gravity
  - Fourier-transform infrared spectroscopy (FTIR) — Vibrational spectroscopy
  - Laser Ablation Laser Induced Breakdown Spectrometry (LIBS) — Elemental analysis (ppm)
  - Inductively Coupled Plasma (ICP) Mass Spectroscopy (MS) and Optical Emissions Spectroscopy (OES) — Elemental analysis (sub-ppm)
  - Thermal Ionization Mass Spectrometry (TIMS) — Elemental Analysis (sub-ppb) — time consuming, costly , ultra-accurate results
  - Liquid Scintillation Counting — Quantify the radioactivity of low energy radioisotopes, mostly beta-emitting and alpha-emitting
  - Ultraviolet/Visible Spectrometry — Speciation, Oxidation States

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